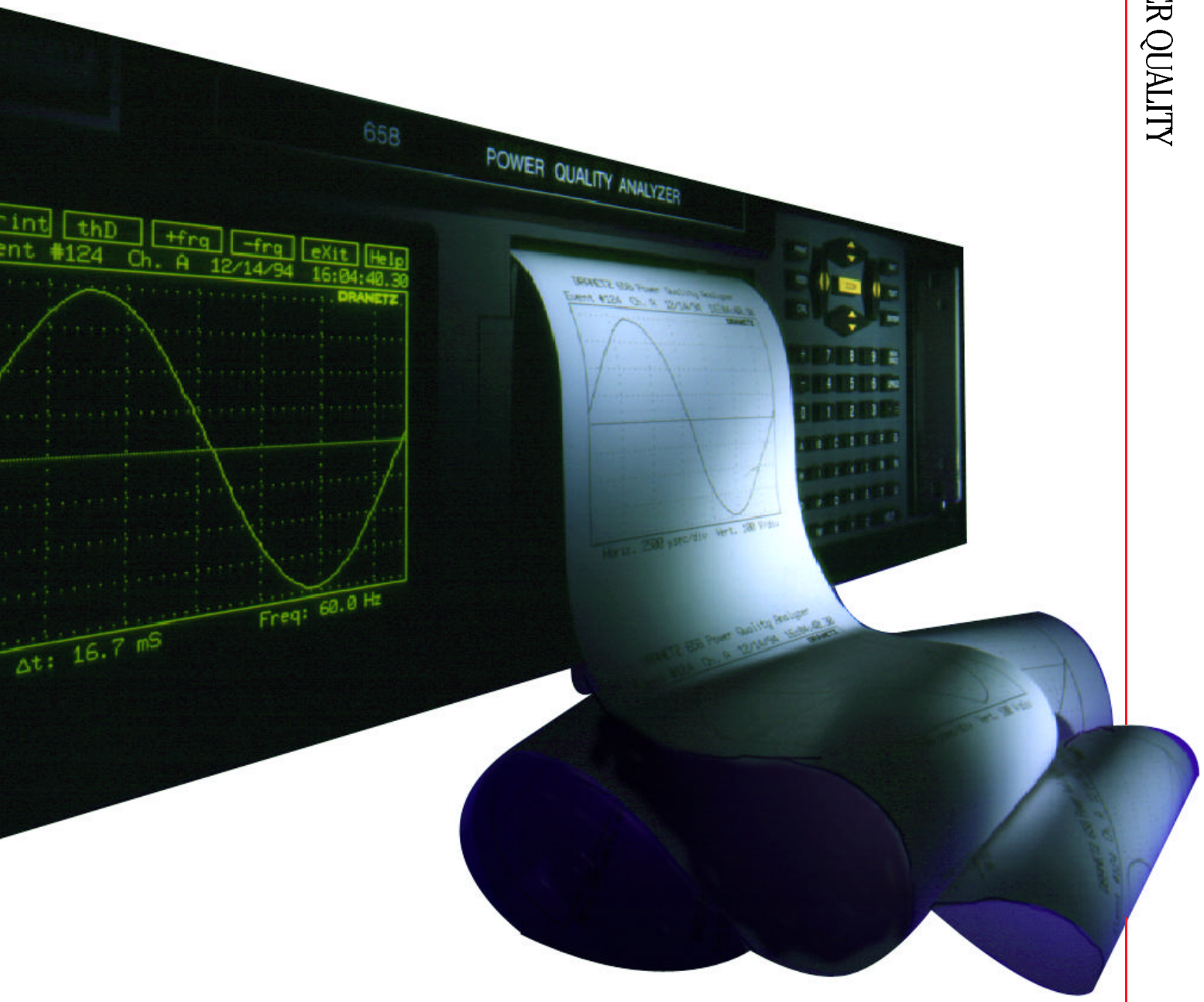
658
POWER QUALITY ANALYZER
thD
+frq
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Help
#124 Ch. A 12/14/94 16:04:40.30
DRANETZ
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WORKING WITH YOU TO ENSURE RELIABLE POWER QUALITY

The electric service that Salt River Project (SRP) provides to commercial, industrial and residential customers is one of the most reliable in the Southwest. However, all electric distribution systems are subject to occasional power disturbances. In the event of a power disturbance, SRP is prepared with a team of technical experts and an efficient support system to respond to your needs quickly. But even when SRP's voltage supply is constant, internally-generated disturbances can affect your operations. The following information is our way of working in Partnership with you to help identify disturbances and prevent those that can originate in your own electrical distribution system.

GUIDELINES TO HELP YOU MAINTAIN PROPER FUNCTIONING OF YOUR VOLTAGE-SENSITIVE EQUIPMENT

This booklet is designed to help you identify the types and sources of voltage disturbances that can affect your sensitive electrical equipment. It discusses the equipment that is most likely to be affected and explains measures you can take to guard against equipment malfunctions and service interruptions.

Equipment most susceptible to problems during power disturbances includes:

- Equipment designed to operate only within narrow voltage limits.
- Equipment lacking adequate buffering systems or override capabilities to filter out normal fluctuations in the electric supply.

Voltage disturbances can occur for a variety of reasons ranging from inadequate design in construction or maintenance of a building's internal wiring system to location of sensitive equipment near disturbance-producing devices.

Note: SRP adheres to the voltage tolerances of American National Standards Institute (ANSI) C84.1. This document provides guidelines for the delivery of electric power at the customer's service entrance. The voltage ranges are plus 5% and minus 5% of the nominal system voltage. (Example: 114 volts to 126 volts is allowed for a 120-volt nominal system at the service entrance.)

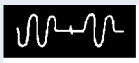
This standard does not include the very short duration interruptions (momentary interruptions).

TYPES OF DISTURBANCES

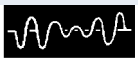
The quality of electric power can be measured by the way it affects the performance of your equipment. Electric power that is totally free of disturbances is sometimes referred to as "clean" power. Clean power is characterized by a constant voltage at a constant frequency.

No utility can consistently provide clean power; weather conditions and other factors (see following page) preclude such a luxury. The main types of voltage disturbances include the following:

- ▼ Interruptions
- ▼ Distortion
- ▼ Noise
- ▼ Flicker
- ▼ Voltage Sags
- ▼ Transients
- ▼ Voltage Swells
- ▼ Frequency Deviations



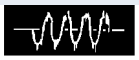
INTERRUPTIONS: Interruptions occur when the voltage levels drop to zero. Interruptions are classified as momentary, temporary or long-term. Momentary interruptions occur when service is interrupted, but then automatically is restored in less than two seconds. Temporary interruptions occur when service is interrupted for more than two seconds but automatically restored in less than two minutes. Long-term interruptions last longer than two minutes and may require field work to restore service. In some cases, momentary outages may go unnoticed or cause no apparent problems. However, even momentary outages can last long enough to shut down computers and disrupt the operation of sensitive electrical equipment.



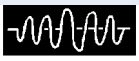
VOLTAGE SAGS: A voltage sag is a short duration decrease in voltage values. Voltage sags more than two minutes are classified as undervoltages. Common causes of voltage sags and undervoltages are short circuits (faults) on the electric power system, motor starting, customer load additions and large load additions in the utility service area. Sags can cause computers and other sensitive equipment to malfunction or simply shut off. Undervoltage conditions can damage certain types of electrical equipment.

DISTORTION (HARMONICS): Distortion occurs when harmonic frequencies are added to the 60 Hertz (60Hz) voltage or current waveform, making the usually smooth wave appear jagged or distorted. Distortion can be caused by solid-state devices such as rectifiers, adjustable speed controls, fluorescent lights and even computers themselves. At high levels, distortion can cause computers to malfunction and cause motors, transformers and wires to heat up excessively. Distortion is probably the most complicated and least understood of all power disturbances.

TRANSIENTS: Transients are sudden but significant deviations from normal voltage or current level. Transients last from 200 millionths of a second to half a second. Transients are typically caused by lightning, electrostatic discharges, load switching or faulty wiring. Transients can erase or alter computer data, resulting in difficult-to-detect computational errors. In extreme cases, transients can destroy electronic circuitry and damage electrical equipment.



NOISE: Noise, or more specifically electrical noise, is a rapid succession of transients tracking up and down along the voltage waveform. The magnitude of these rapid transients is usually much less than that of an isolated transient. Noise often originates in electrical motors and motor control devices, electric arc furnaces, electric welders, relays, and remote atmospheric discharges such as lightning. Although less destructive than a large rapid transient, electrical noise can cause computers to malfunction and can interfere with the operation of communications equipment or other sensitive electronic equipment.



VOLTAGE SWELLS: A voltage swell is a short duration increase in voltage values. Voltage swells lasting longer than two minutes are classified as overvoltages. Voltage swells and overvoltages are commonly caused by large load changes and power line switching. If swells reach too high a peak, they can damage electrical equipment. The utility's voltage regulating equipment may not react quickly enough to prevent all swells or sags.

FLICKER: Flicker can be defined as small amplitude changes in voltage levels occurring at frequencies less than 25 Hertz (25Hz). Flicker is caused by large, rapidly fluctuating loads such as arc furnaces and electric welders. Flicker is rarely harmful to electronic equipment, but is more of a nuisance because it causes annoying, noticeable changes in lighting levels.

FREQUENCY DEVIATIONS: Normal utility power in the United States is supplied at a frequency of 60 cycles per second, or 60 Hertz (60Hz). On large interconnected utility systems such as SRP's, frequency is very stable and deviations rarely are a problem. However, on smaller power systems, especially those supplied by on-site generators, frequency deviations can cause electronic equipment to malfunction and affect the speed of motor-driven clocks.

SOURCES OF DISTURBANCES

SALT RIVER PROJECT'S ELECTRIC SYSTEM

The Salt River Project's electric system is subject to a number of influences that can cause voltage disturbances. Some of the most common are:

- Lightning and wind
- Power line switching
- Vehicular accidents involving utility poles or pad-mounted equipment
- Dig-ins of underground electrical lines
- Damage to wires by trees
- Animals and birds making contact between conductors
- Outages of the electric utilities interconnected with the SRP system
- Equipment malfunctions
- Insulator flashovers
- Vandalism

The frequency and extent of the disturbances that you may experience depend largely on weather conditions and on your location within the SRP electric service area.

YOUR ELECTRIC SYSTEM

Power disturbances originating in your own electrical distribution system also can cause problems for sensitive electrical equipment. These disturbances can occur more frequently and appear more severe due to the close proximity of the sensitive equipment to the disturbance source. Even an appliance as seemingly innocent as an office coffee pot may pose a hazard to a small computer or other electronic devices.

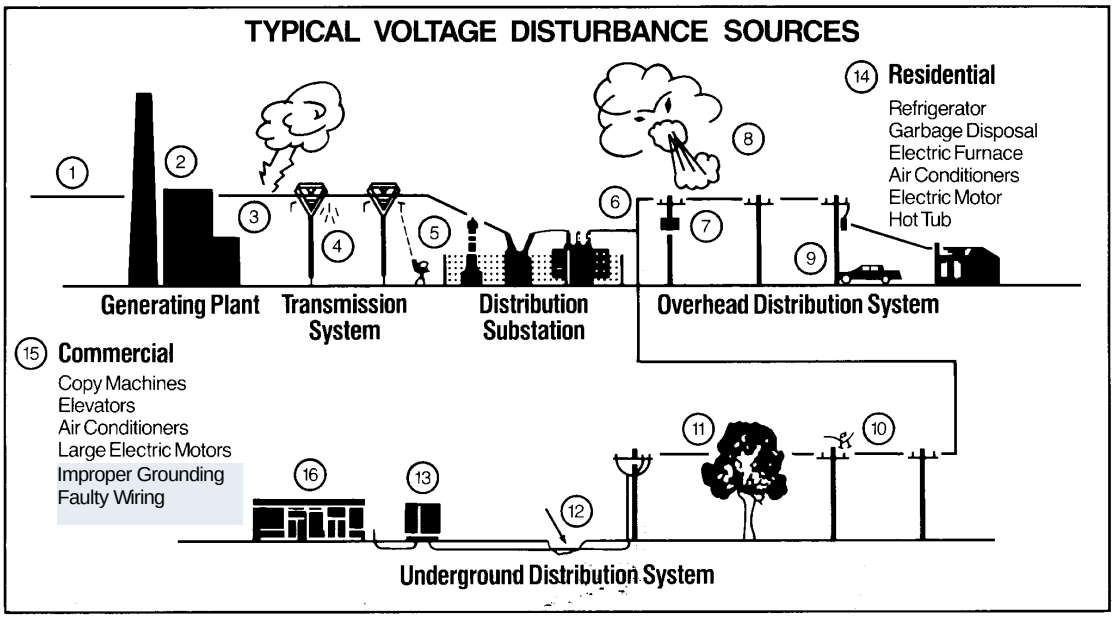
Some of the more common sources of power disturbances within commercial and industrial operations are:

- Laser printers
- Copy machines
- Elevators
- Air conditioners
- Electric furnaces
- Rectifiers
- Adjustable speed controls
- Electric welders
- Fluorescent lights
- Large electric motors
- Vending machines
- Electronic power supplies
- Telephone switching equipment

Even residential equipment can cause problems for sensitive devices. Refrigerators, garbage disposals, electric furnaces, air conditioning, large electric motors and hot tubs can cause disturbances. In general, any device that draws inconsistent power or has a high in-rush of current at start-up can cause problems.

Other common sources of power disturbances originating from within your electrical distribution system can include:

- Improper grounding
- Faulty wiring
- Loose or improper electrical connections
- Excessive load additions



1. Outage on interconnected system
2. Equipment malfunctions at generating plant
3. Lightning strike
4. Insulator flashover
5. Insulator damaged by vandalism
6. Voltage disturbance on one line affects another line
7. Automatic switch opens and recloses to protect shorted equipment
8. Wind causes damage to overhead lines
9. Car/pole accident
10. Bird makes contact between two conductors
11. Tree damage to wires
12. Dig-in cuts underground line
13. Utility equipment failure
14. Residential disturbances
15. Commercial disturbances
16. Voltage-sensitive equipment

SENSITIVE EQUIPMENT

Some equipment requires an extremely constant voltage supply to operate reliably. Costly and time-consuming procedures often are required to restore such equipment to normal operation after a voltage disturbance.

The types of equipment that may be sensitive to voltage disturbance include:

- Computers, personal and business
- Electronic apparatus in general
- Electronic process controls
- Security systems
- Electronic cash registers
- Controllers for chillers, sprinklers, etc.
- Digital clocks
- Microwave ovens
- Videocassette recorders
- Programmable controllers
- Automated manufacturing systems
- Electronic energy management systems
- Telephone switching equipment
- Electronic/Memory typewriters
- Copy machines
- Medical diagnostic or treatment equipment

RECOMMENDED PROTECTION PROCEDURES

You can protect your sensitive equipment in a number of ways. Some may be as simple and inexpensive as repairing faulty wiring. Others may involve the purchase of costly power conditioning devices. As with any piece of electrical equipment, always make sure that you have installed your sensitive equipment in accordance with the manufacturer's instructions and all applicable electrical safety codes. A recommended step-by-step procedure follows:

1. ECONOMIC ASSESSMENT: Determine the economic impact of electrical service disturbances or interruptions. If little time or cost is involved when interruptions occur, the most economical solution may be to ignore the interruption and in the case of computer malfunctions, to re-enter the lost data or institute data backup procedures. You are best qualified to make the proper judgement.

2. INDIVIDUAL BRANCH CIRCUIT: Place the sensitive electrical device on an individual branch circuit that supplies power to that device only. Occasionally, service interruptions to computers and other sensitive equipment can be caused by machines or office equipment improperly placed on the same electrical circuit (or supplied from the same electric distribution panel) as the sensitive device.

3. PROPER GROUNDING: Ensure that all voltage-sensitive equipment is properly grounded. Equipment can be made less susceptible to voltage disturbances if the electrical wiring is properly grounded. Grounding involves not only the equipment itself but also the electrical circuit, surrounding electrical equipment and metallic structural parts of the building. (Please refer to the latest edition of the National Electrical Code, Article 250.)

4. MANUFACTURER ASSISTANCE: Contact the manufacturer of the sensitive equipment if procedures 1-3 do not work. The manufacturer may be able to offer suggestions.

5. PREVENTIVE MAINTENANCE: Adopt a program of preventive maintenance. Regular maintenance of voltage-sensitive equipment and electrical circuits may reduce the equipment's susceptibility to voltage disturbances. A maintenance program should be developed in consultation with the equipment manufacturer and your company's qualified technical representative.

6. POWER QUALITY MONITOR: Install a power quality monitor on the electrical supply line serving the voltage-sensitive equipment. Power quality monitors record power line disturbances and may help to identify the source of the disturbance.

7. ENGINEERING CONSULTANT OR ELECTRICIAN: Select a qualified engineering consultant or electrician. The consultant can help interpret the results of the power quality monitoring and determine corrective action. A good electrician can help correct faulty wiring or improper grounding.

8. PROPER BUFFERING: Install proper buffering equipment or protective devices to reduce or eliminate the impact of power disturbances on your voltage-sensitive equipment. The choice of an appropriate device will depend on the type of disturbance, the overall effect of disruptions on sensitive equipment, the desired degree of service reliability and the total cost of the buffering equipment.

BUFFERING EQUIPMENT

Many different types of buffering devices are available, each with a specific application. (See table on page 7.) Some of the more common types are:

SURGE SUPPRESSORS (SPIKE CLIPPERS): Surge suppressors either limit transients or divert them to the ground so that they are not passed through to sensitive equipment. SRP recommends that you use surge suppressors that comply with the Underwriters Laboratories (UL) Standard 1449 and are marked as such.

FILTERS: Filters can be used to screen out high-frequency noise or harmonics. Some surge suppressors incorporate filters as an added feature.

ISOLATION TRANSFORMERS: Isolation transformers are devices designed to reduce, or in some cases virtually eliminate, the effect of transients and electrical noise. Several types are available; those with multiple shields usually provide the best protection.

VOLTAGE REGULATORS: Voltage regulators are devices designed to protect sensitive equipment against overvoltages and undervoltages. Some of the more sophisticated types can respond quickly enough to protect against swells and sags.

POWER CONDITIONERS: Among the more common types are:

1. A combination isolation transformer and voltage regulator in a single unit.
2. A motor-generator (M-G) set.

UNINTERRUPTIBLE POWER SUPPLIES (UPS): UPS units can provide the most effective but most costly protection against all voltage disturbances. UPS units are either static type, using solid-state components, or rotary type, using M-G sets. UPS systems usually contain either a large battery or bank of batteries that provide emergency power to critical equipment without interruption during outages. Most UPS systems are designed to have only enough battery supply to allow for a controlled shutdown of computers to prevent loss of data. Extremely critical loads, such as hospital equipment, require emergency backup generators that can supply power for extended periods of time.

STANDBY POWER SUPPLIES (SPS): For smaller loads, a less costly version of the UPS is available. Like the UPS, the SPS utilizes batteries to provide power during outages. Unlike the UPS, however, the SPS switches from utility power to the battery resulting in a short power interruption. This must be taken into account when using the SPS with voltage-sensitive equipment.

BUFFERING EQUIPMENT APPLICATIONS

Type of Equipment	Type of Disturbance							
	Transient	Sag	Swell	Interruption	Distortion (Harmonics)	Flicker	Noise	Frequency Deviation
Surge Suppressor	Yes	No	No	No	No	No	No(1)	No
Filter	No	No	No	No	Yes (2)	No	Yes	No
Isolation Transformer	Yes	No	No	No	No(3)	No	Yes	No
Voltage Regulator	No	Yes	Yes	No	No	No	No	No
Power Conditioner	Yes	Yes	Yes	No(4)	No(5)	No	Yes	No
Uninterruptible Power Supplies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Standby Power Supplies	No	No	No	Yes (6)	No	No	No	No

Notes to Table: 1. Some surge suppressors incorporate filters to reduce noise. 2. Filter must be properly designed to be effective against harmonic distortion. 3. Well-designed isolation transformers can reduce some harmonic distortion. 4. Motor-Generator sets provide limited protection against momentary interruptions. 5. Motor-Generator sets can protect against harmonic distortion. 6. Standby Power Supply units may not protect against momentary interruptions.

SUMMARY

PLANNING FOR DISTURBANCES

To get the best performance from computer and other sensitive electrical equipment, be sure to plan for voltage disturbances. Ensure that the building's electrical system is designed to accommodate the desired equipment and then consider protective equipment to provide the level of reliability required.

TECHNICAL GUIDES

Users of medium and large scale computer or automatic data processing (ADP) systems should refer to one of the following publications:

1. "Guideline on Electrical Power for ADP Installations," Federal Information Processing Standards Publication (FIPS #94). This guideline is a reference document on electrical power, grounding and safety for ADP installations. Copies of the publication are sold by the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4600.

2. "IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment," (Emerald Book), Institute of Electrical and Electronics Engineers Standard 1100-1992. This publication, recognized as an American National Standard Institute (ANSI), provides recommended design, installation, and maintenance practices for electrical power and grounding of sensitive electronic processing equipment used in commercial and industrial applications. Copies of the publication are sold by the IEEE, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, (800) 678-4333.

SALT RIVER PROJECT.
WORKING IN PARTNERSHIP WITH YOU.

SRP continues to look for ways to work with you to ensure the best quality power service for your specific applications. If you have questions about the quality of your electric power, please call your SRP Marketing Department Representative at 236-4444.

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